

MULTIMEDIA



UNIVERSITY

STUDENT ID NO

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MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 1, 2022/2023 (TERM ID 2215)

ERR2036 – ROBOTICS – MACHINE DESIGN AND MECHANISMS (EC01)

**20 FEBRUARY 2023
2.30 PM – 4.00 PM
(1.5 Hours)**

INSTRUCTIONS TO STUDENT

1. This is an Open Book exam, you may bring and refer to your Lecture Slides during the exam.
2. This Question paper consists of 4 pages including cover page with 3 Questions only.
3. Attempt all questions. The distribution of the marks for each question is given.
4. Please print all your answers in the answer Booklet provided.

Question 1

Figure Q1 shows a crank-and-slide mechanism driven by an electric motor with gearset.

- (a) Analyze the degree of freedom for the planar linkages using Gruebler-Kutzbach method. List down all the links and joints in Figure Q1 (You may sketch a figure and label all the joints and links).

[5 marks]

- (b) Briefly describes the characteristics of the movement of Link A and Link B when the electric motor is turning the wheel counter-clockwise. Use suitable diagrams if needed.

[7 marks]

- (c) For the gear system shown in Figure Q1, determine the output torque if the pinion is driven by an electric motor with torque of 0.012 N/m at the output shaft. The number of teeth in pinion is 14, while the number of teeth in the spur gear is 70. Ignore any frictional force.

[3 marks]

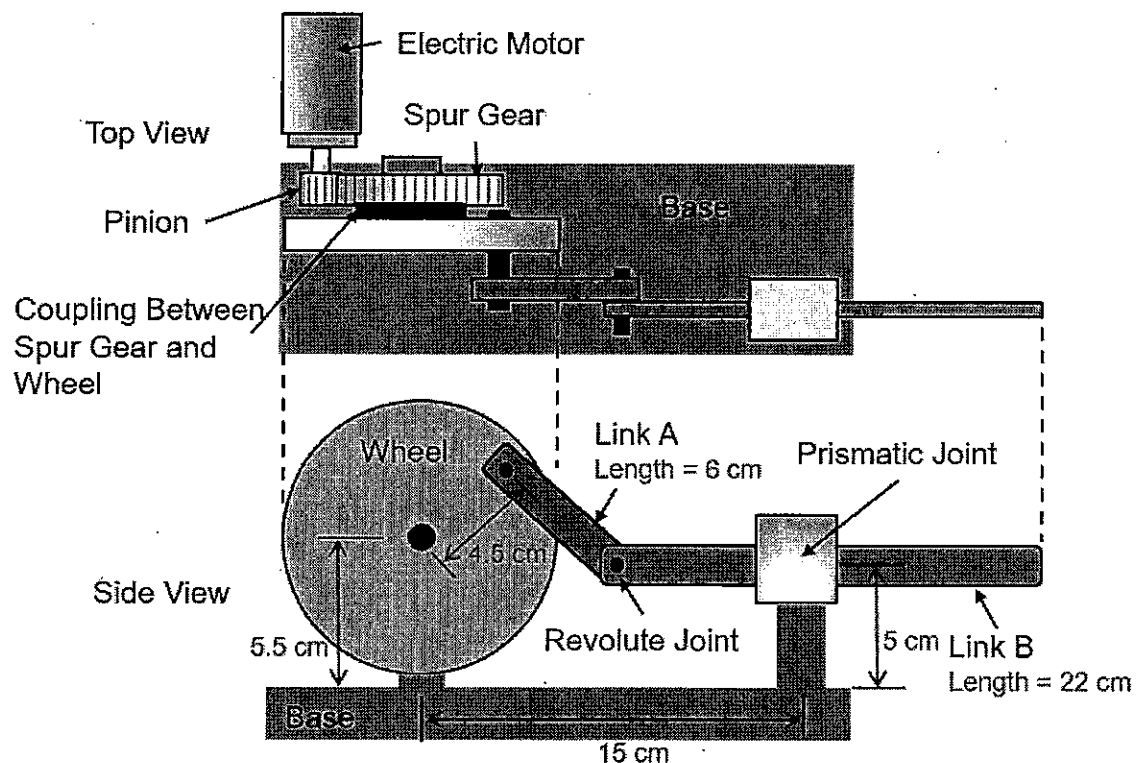


Figure Q1.

Continued...

Question 2

- (a) List TWO (2) advantages of titanium compare to steel.

[2 marks]

- (b) Figure Q2 shows some nyloc nuts, or nylon-insert nuts being used, together with bolts to attach a cover to a machine body. Briefly explain the use of the nylon insert. Also suggest an alternative if nyloc nuts are not used.

[3 marks]

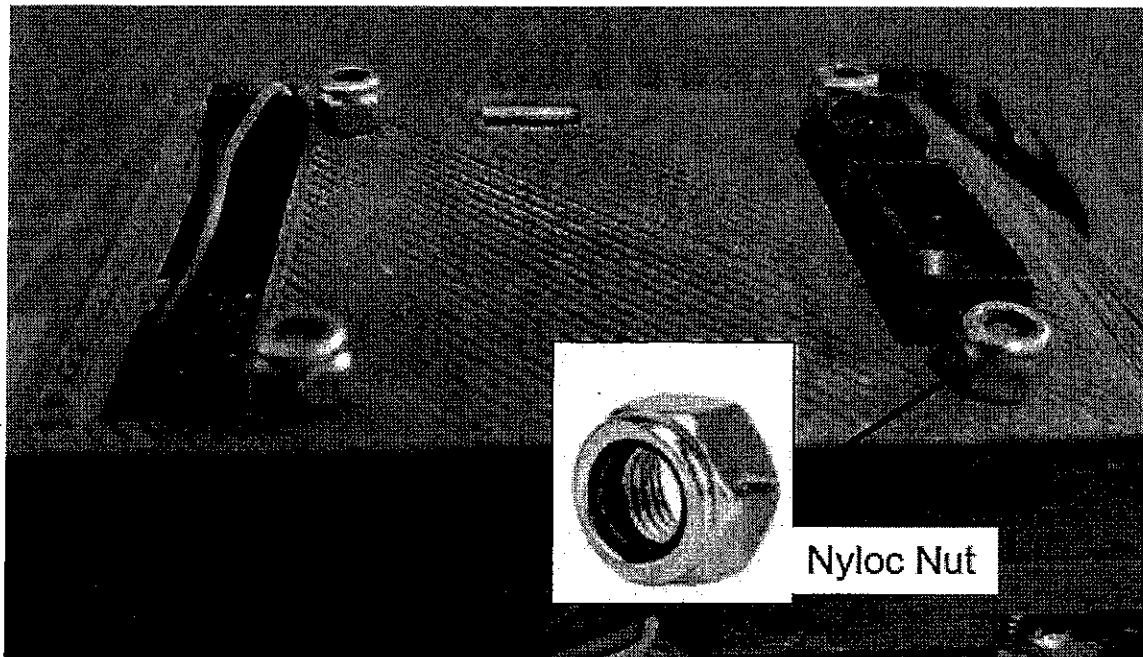


Figure Q2.

- (c) A square aluminum rod with cross section area of 5.0×5.0 mm forms part of the support structure for a load-carrying mobile robot. Under normal operation the aluminum rod experiences a tensile stress of 100 N.
- (i) If the original length of the aluminum rod is 150 mm, determine the actual length of the rod under normal tensile stress. (Young's modulus $E = 70 \times 10^9$ N/m²)
- (ii) Determine the maximum tensile force that can be applied to rod if the ultimate tensile strength for aluminum is 200×10^6 N/m². Use a safety factor of 0.3.

[6 + 4 marks]

Continued...

Question 3

A rubber wheel is connected to an electric motor (Figure Q3). The wheel has a diameter of 15 cm, width of 6 cm and mass of 1.1 kg. Assume the mass of the wheel is evenly distributed.

- (a) Determine the moment inertia of the wheel.

[2 marks]

- (b) If the rotor of the electric motor has a moment inertia of $1.7 \times 10^{-5} \text{ kgm}^2$, determine the rotational kinetic energy in the wheel-rotor assembly when the wheel is rotating at a rate of 300 rpm.

[4 marks]

- (c) If the wheel-rotor assembly can reach the rotation speed of 300 rpm from rest within 0.3 seconds, calculate the required instantaneous power needed from the electric motor when the wheel is rotating at 300 rpm, ignore any frictional force in the system (hint: find the angular acceleration first).

[4 marks]

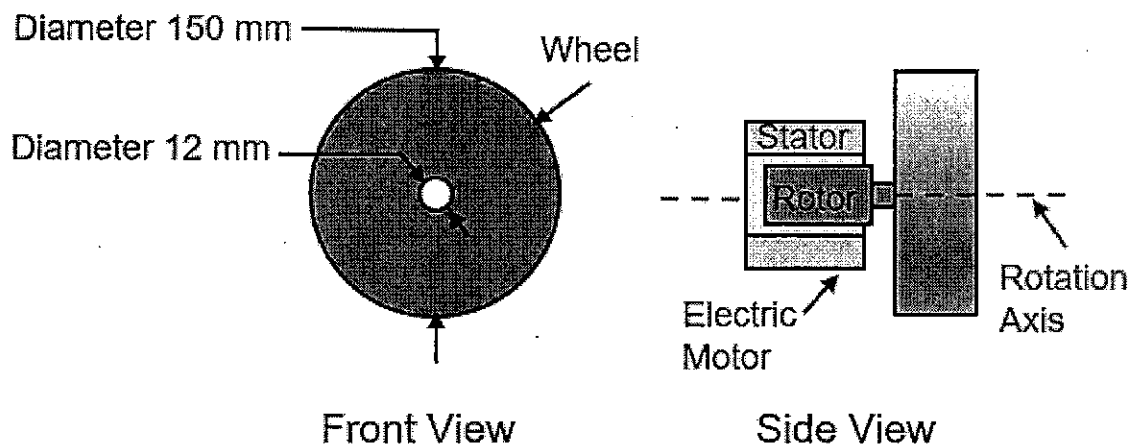


Figure Q3.

End of Paper.